

FY96 CONVENTIONAL ARMAMENT TECHNOLOGY AREA PLAN



19950929 012

HEADQUARTERS AIR FORCE MATERIEL COMMAND

DIRECTORATE of SCIENCE & TECHNOLOGY

WRIGHT-PATTERSON AFB OH

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.

"Note: This Technology Area Plan (TAP) is a planning document for the FY96-02 Science and Technology (S&T) program and is based on the President's FY96 Budget Request. It does not reflect the impact of the FY96 Congressional appropriations and FY96-02 budget actions. You should consult WL/XP, (904) 882-8591, for specific impacts that the FY96 appropriation may have had with regard to the contents of this particular TAP. This document is current as of 1 Aug 1995."

About the cover: In a joint program, the Armament Directorate and the Air-to-Surface Weapons System Programs Office demonstrated an enhanced 1000-pound explosive (pictured) that has the equivalent blast performance of a 2000-pound blast/fragmentation warhead filled with conventional Tritonal explosive.

Accession For	
NTIS GRA&I	<input checked="checked" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/Sec	
Availability Codes	
Avail and/or	Special
Dist	
A-1	

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.					
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE Jul 1995		3. REPORT TYPE AND DATES COVERED Final	
4. TITLE AND SUBTITLE FY96 Conventional Armament Technology Area Plan				5. FUNDING NUMBERS 62602F 63601F	
6. AUTHOR(S) Morgan, K.D. Brinson, A.D. Simpson, L.B. Webb, R. N. Hill, R.L.					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) WL/MNP Armament Directorate Air Force Material Command 101 West Eglin Boulevard, Ste 140 Eglin AFB FL 32542-6810				8. PERFORMING ORGANIZATION REPORT NUMBER WL-TR-96-7000	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) WL/MN Armament Directorate Air Force Material Command 101 West Eglin Boulevard, Ste 101 Eglin AFB FL 32542-6810				10. SPONSORING/MONITORING AGENCY REPORT NUMBER WL-TR-96-7000	
11. SUPPLEMENTARY NOTES					
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for Public Release; Distribution Unlimited				12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) The FY96 Conventional Armament Technology Plan (TAP) is used to explain and outline the technologies and programs the Wright Laboratory Armament Directorate, Eglin AFB, FL performs. It is reviewed by the Air Force Science and Technology community to inform and to report Air Force activities throughout the Air Force Laboratories. The TAP provides the reader with the Armament Directorate's Vision, basic funding, and major accomplishment of the major technology thrust areas at the Armament Directorate. These thrusts are a) the Advanced Guidance Thrust, b) the Ordnance Thrust, and c) the Instrumentation Thrust. The Conventional Armament TAP is one of several technology plans that supports Wright Laboratory, Wright-Patterson AFB OH. <div style="text-align: right;">DTIC QUALITY INSPECTED 8</div>					
14. SUBJECT TERMS Armament Advanced Guidance Hard Target Penetrator Ordnance Instrumentation Technology Laser Radar Seeker/Sensor				15. NUMBER OF PAGES 29	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified		18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified		19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	
				20. LIMITATION OF ABSTRACT UL	

GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to *stay within the lines* to meet *optical scanning requirements*.

Block 1. Agency Use Only (Leave blank).

Block 2. Report Date. Full publication date including day, month, and year, if available (e.g. 1 Jan 88). Must cite at least the year.

Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10 Jun 87 - 30 Jun 88).

Block 4. Title and Subtitle. A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.

Block 5. Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C - Contract	PR - Project
G - Grant	TA - Task
PE - Program Element	WU - Work Unit Accession No.

Block 6. Author(s). Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

Block 7. Performing Organization Name(s) and Address(es). Self-explanatory.

Block 8. Performing Organization Report Number. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

Block 9. Sponsoring/Monitoring Agency Name(s) and Address(es). Self-explanatory.

Block 10. Sponsoring/Monitoring Agency Report Number. (If known)

Block 11. Supplementary Notes. Enter information not included elsewhere such as: Prepared in cooperation with...; Trans. of...; To be published in.... When a report is revised, include a statement whether the new report supersedes or supplements the older report.

Block 12a. Distribution/Availability Statement. Denotes public availability or limitations. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g. NOFORN, REL, ITAR).

DOD - See DoDD 5230.24, "Distribution Statements on Technical Documents."

DOE - See authorities.

NASA - See Handbook NHB 2200.2.

NTIS - Leave blank.

Block 12b. Distribution Code.

DOD - Leave blank.

DOE - Enter DOE distribution categories from the Standard Distribution for Unclassified Scientific and Technical Reports.

NASA - Leave blank.

NTIS - Leave blank.

Block 13. Abstract. Include a brief (*Maximum 200 words*) factual summary of the most significant information contained in the report.

Block 14. Subject Terms. Keywords or phrases identifying major subjects in the report.

Block 15. Number of Pages. Enter the total number of pages.

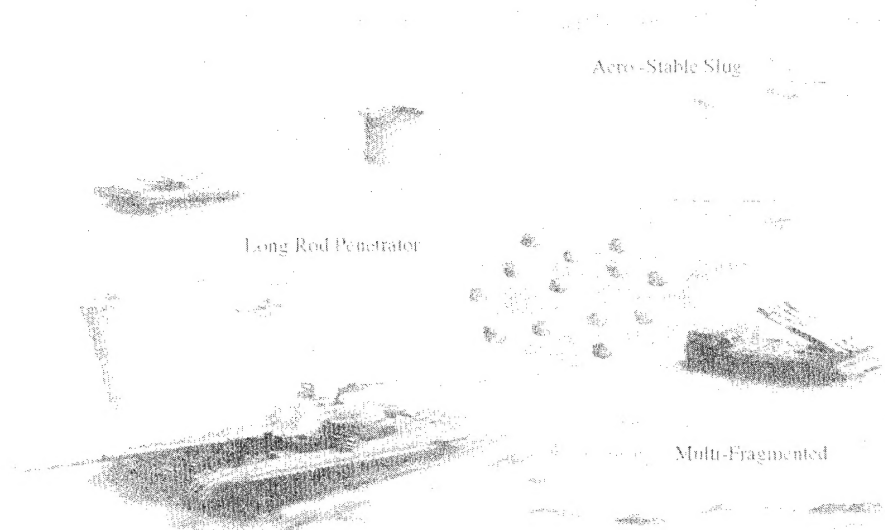
Block 16. Price Code. Enter appropriate price code (*NTIS only*).

Blocks 17. - 19. Security Classifications. Self-explanatory. Enter U.S. Security Classification in accordance with U.S. Security Regulations (i.e., UNCLASSIFIED). If form contains classified information, stamp classification on the top and bottom of the page.

Block 20. Limitation of Abstract. This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.

CONVENTIONAL ARMAMENT

Advanced Multi-Mode Warhead Technology



VISIONS AND OPPORTUNITIES

During the first half of this decade, the United States saw an increase in regional conflicts, a proliferation in weapons of mass destruction, and an increased demand for our peacekeeping and humanitarian efforts. At the same time, our nation saw our force structure being reduced, and the development and production of new weapon systems being sharply curtailed. The net effect is the fact that we must do more with less. This realization has elevated the importance of the development of affordable and effective conventional weaponry.

The development of conventional weapons is increasingly important in today's environment due to the requirement to strike military targets while minimizing the loss to life and resources. Therefore, the development of versatile conventional weapons capable of destroying all types of

targets ranging from hardened, buried command facilities to mobile SCUD launchers is necessary to limit the need for nuclear weapons. Precision guidance systems are needed that allow our forces to surgically strike military targets thus reducing the risk to civilian populations and minimizing environmental damage. The Armament Directorate is committed to providing the research and development efforts that can provide the necessary conventional weaponry for our future Air Force needs.

Our vision is to pursue development of affordable, autonomous, all weather, precision guided weapons. The terminal seeker of today can obtain accuracies ranging from 30 to 3 feet circular error probable (CEP) at costs of \$150K and \$500K, respectively. A seeker with a near zero CEP

at a cost of under \$10K per unit in production quantities is our goal. Seekers with totally passive modes of operation or that emit low probability of intercept signals are being sought to enhance aircraft survivability. Work continues toward advancing processor design and algorithm development to simplify mission planning and to provide weapons capable of identifying the target being attacked. Together these works can lead to effective stand-off attack weapons with precision strike capabilities.

We envision using improved conventional weapons to defeat targets that were once only vulnerable to nuclear weapons. The continued development of munitions with deeper penetration and better blast/fragmenting capabilities is critical to place these targets at risk.

We also recognize that our technologies must be packaged for effective delivery from advanced weapon platforms. This requires incorporating our weapon airframe, carriage/release, and weapon integration expertise into the overall conventional weapon development process.

The reduction of our force structure means we must not only readdress our war fighting abilities but improve our methods of maintaining those abilities as well. This vision can be achieved by the continued

development of cheaper, safer, and more effective weapons that reduce logistic center inventories and weapon life cycle costs. Our multi-mode warhead technology will provide the ability to defeat a broad spectrum of antimateriel targets with a single warhead, therefore, reducing the number of unique weapons to be carried in the inventory.

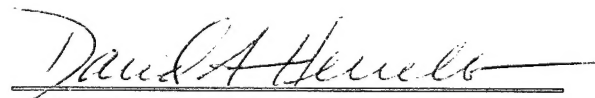
The advancements in simulation and analysis techniques will enable us to reduce the cost of research, test, and acquisition of weapons while reducing the impact on the environment. New modeling and simulation capabilities allow for improved system and subsystem effectiveness comparisons eliminating the need for tests harmful to the environment. The need for expensive test facilities and equipment can be minimized as a result of advanced computational fluid dynamic codes performing the same analysis and evaluations. In addition, the development of advanced test instrumentation will allow the effective gathering of accurate data, reduce the amount of testing, and provide better performance predictions.

The development of highly effective and affordable conventional armament technologies for the Air Force is our vision. We obtained this vision by using the talented personnel and unique facilities available at the Armament Directorate, Eglin AFB.

This plan has been reviewed by all Air Force laboratory commanders/directors and reflects integrated Air Force technology planning. We request Air Force Acquisition Executive approval of the plan.



RICHARD R. PAUL
Brigadier General, USAF
Technology Executive Officer



DAVID A. HERRELKO, Colonel, USAF
Commander
Wright Laboratory

CONTENTS

	Page
Visions and Opportunities.....	i
Introduction.....	1
Program Description	
Thrust 1. Advanced Guidance.....	4
Thrust 2. Ordnance.....	11
Thrust 3. Instrumentation Technology.....	19
Glossary	23
Technology Master Process Overview.....	25
Index	27

CONVENTIONAL ARMAMENT TECHNOLOGY AREA PLAN

INTRODUCTION

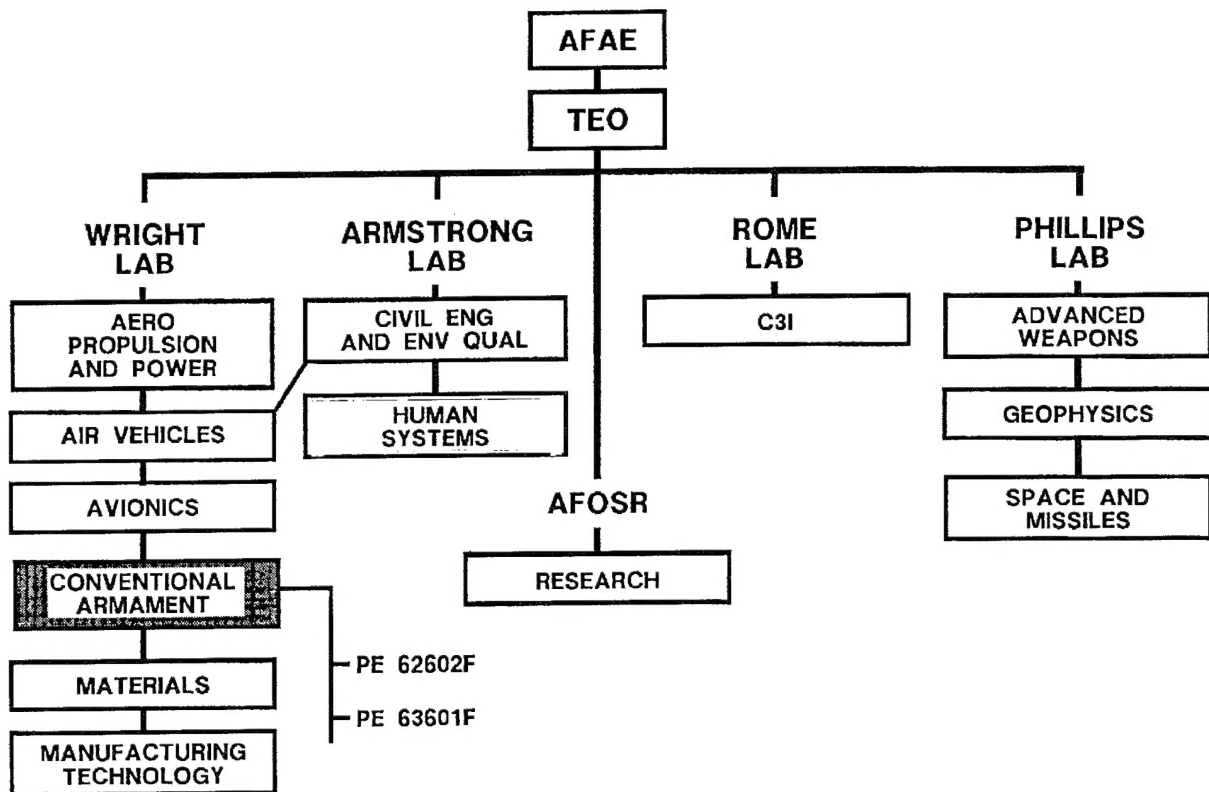


FIGURE 1. AIR FORCE SCIENCE AND TECHNOLOGY PROGRAM STRUCTURE

Background

The Air Force Materiel Command organization for Science and Technology (S&T) is depicted in Figure 1. Within this structure, Conventional Armament S&T is carried out by the Armament Directorate at Eglin Air Force Base (AFB), FL. We have two Program Elements (PE) as shown. The primary role of the Armament Directorate is to perform research and development to transition conventional armament

technologies that meet our customers' needs. Figure 2 illustrates the FY96 Conventional Armament investment compared to the overall Air Force S&T budget. Conventional Armament is less than six percent of the S&T budget excluding National Aerospace Plane (NASP) and Joint Advanced Strike Technology (JAST) funding.

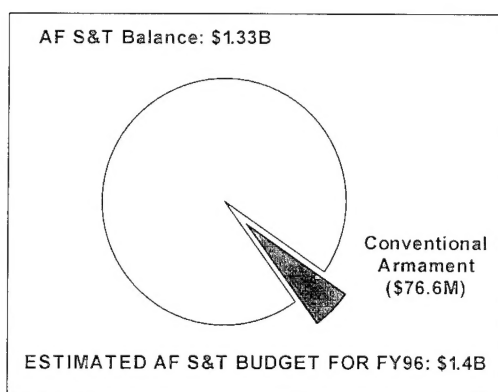


FIGURE 2. CONVENTIONAL ARMAMENT S&T vs AIR FORCE S&T

The fundamental technology areas or major thrusts for Conventional Armament are shown in Table 1.

Table 1. Major Technology Thrusts

1. Advanced Guidance
2. Ordnance
3. Instrumentation Technology

These thrusts encompass a broad spectrum of technologies that form the basis for enabling new/innovative concepts for air-launched weapons. **To relate User's Needs to conventional armament technology, the thrust descriptions begin with an abbreviated listing of combat user needs extracted from Mission Area Plans and other requirements documents. These needs are expanded and highlighted in boldfaced type in the "Goals" section along with the technologies being pursued to solve the needs.** The thrust descriptions conclude with accomplishments last year, program changes, and milestones for the future.

Figure 3 is the apportionment of AF Science and Technology (S&T) conventional armament funding for the three major thrusts.

The Advanced Guidance Thrust develops terminal seekers and guidance systems for

weapons to provide them with precision guidance. Accomplishments during the past year include advancements in high speed processing of target imagery, the reduction in seeker component costs, as well as captive flight testing of advanced Synthetic Aperture Radar (SAR) and Laser Radar (LADAR) seekers.

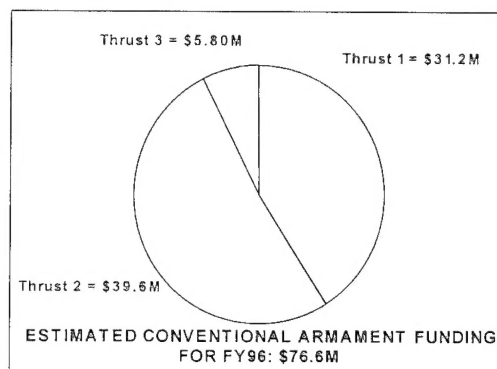


FIGURE 3. MAJOR TECHNOLOGY THRUSTS

Also, advancements were made in the technologies to prevent/reduce jamming effects on weapon Global Positioning System (GPS) receivers. The Ordnance Thrust is responsible for the development of explosives, warheads, fuzes, weapon airframe controls and carriage and release equipment and receives the largest share of the Conventional Armament S&T budget. Major advancements in the development of insensitive explosives and fuzes were accomplished in the past year. This Instrumentation Thrust is concerned with the development of new test instrumentation to reduce weapon test costs and improve test data collection. Major accomplishments in subminiature telemetry and high speed video data collection were made during the past year. Technology assessments are conducted in all of these thrusts to provide program managers insight into critical design issues and to ensure that the technologies are focused to satisfy the user's requirements. All funding figures reflect the FY96 President's Budget Request, and the programs described in this plan are

subject to change based upon possible Congressional action.

Relationship to Other Technology Programs

Our thrusts are coordinated with the other 12 technology areas of Air Force S&T. Special attention is placed on maintaining a close relationship with areas that are vital to armament development such as materials, avionics, air vehicles, and aero propulsion and power. This awareness ensures our thrusts can benefit from work performed in these areas.

To keep abreast of technologies, we participate in joint programs, data exchanges, and technical interfacing with other Air Force organizations, Services, government agencies, National Laboratories, industry, and foreign countries. We maintain an interface and support programs carried out by these organizations so that we can leverage their technical expertise and fill our technical gaps. We also maintain a working relationship with aircraft System Program Offices (SPOs) to provide them with technologies for new weapons, missile launchers and bomb release units for advanced aircraft. Together we work to support each other so that the SPO and our technology needs are met.

We leverage our technologies with the commercial sector where possible. The Advanced Guidance and Instrumentation Technology thrusts develop radars, thermal imagers, processors, and other electronic components that have a large commercial base. We can therefore contract most of our efforts out while conducting some in-house research. Where there is limited commercial interest such as in the explosives, warheads, and fuzes area, we conduct much more in-house research and

expend more resources than private industry to advance this technology. We also draw upon the aircraft industry technology base for airframes, inertial measurement units (IMU), and autopilots; therefore, we can effectively leverage our resources in this area.

The Armament Directorate has implemented a broad based technology transfer program. Outreach to industry, patenting, marketing and cooperative efforts are all a part of the directorate program. We are actively involved with industry through Cooperative Research and Development Agreements to promote the commercialization of Subminiature Telemetry, High Speed Imaging, and Nonthermal Silent Electric Discharge technologies. The Armament Directorate is an active member of the Gulf Coast Alliance for Technology Transfer for the purpose of assessing and commercializing our technologies.

The Directorate has several International Exchange Agreements with foreign countries around the world. The primary emphasis is in the ordnance area with a value of approximately \$1.5 million. A number of joint tests were completed last year and more are scheduled for the coming year.

Changes from Last Year

A major change from last year is the elimination of the Weapon Flight Mechanic's Thrust. This was a consolidation activity with the technologies inside the Weapon Flight Mechanics Thrust supporting navigation and control now being conducted under the Advanced Guidance Thrust. The technologies which directly supported the Ordnance Thrust are now being conducted under that thrust.

THRUST 1 ADVANCED GUIDANCE

USER NEEDS

This Thrust focuses on the development of terminal seeker, sensor, and guidance technologies for weapons that can go anywhere, anytime, accurately, affordably, and autonomously. User needs have been extracted from the Air Combat Command (ACC) Mission Area Plans for Counter Air, Strategic Attack/Interdiction, Close Air Support/ Interdiction, Theater Missile Defense and Electronic Combat.

AIR-TO-SURFACE

Fixed Target/General Purpose Weapon Options (Direct and Standoff)

- Autonomous target identification and tracking in weather with affordable, countermeasure resistant seekers
- Real-time targeting and damage assessment
- Steep dive angle target acquisition and tracking
- Reduced mission planning requirements
- Minimal collateral damage
- Jam resistant Global Positioning System (GPS)/inertial weapon guidance

Mobile Target Weapon Options (Direct and Standoff)

- Autonomous target identification and tracking in weather with affordable, countermeasure resistant seekers
- Real-time targeting
- Identification of friend or foe
- Jam resistant GPS/Inertial weapon guidance

AIR-TO-AIR

Medium Range Missile Options

- Increased electronic countermeasure (ECM) resistance and broader target set
- Identification of friend or foe
- Capability against cruise missiles
- Improved guidance laws/autopilots for enhanced accuracy and faster intercept
- Low cost, small, and accurate Inertial Measurement Units (IMUs)

Short Range Missile Options

- High off-boresight lock-on and track capability with affordable seekers

See Figure 4 for major Thrust efforts.

GOALS

AIR-TO-SURFACE

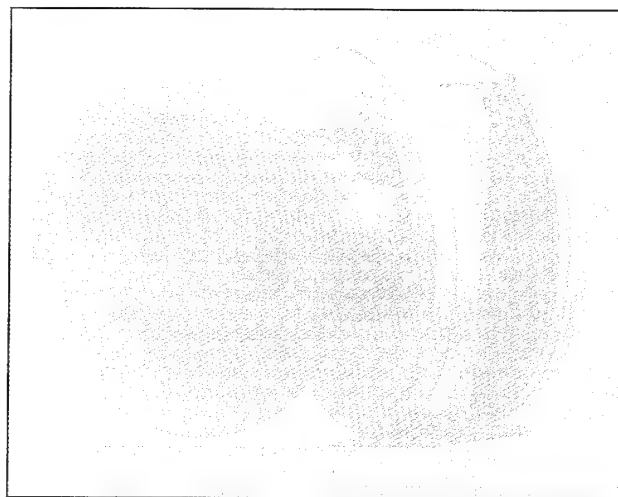


FIGURE 5. SYNTHETIC APERTURE RADAR SEEKER

The air-to-surface laser guided weapons currently in the inventory require designation of the target by laser. A successful mission requires not only that the designator remain in the target area until weapon impact but also that the weather is good enough to allow visual acquisition by both weapon and designator. Desert Storm highlighted this weather limitation and the need for precision guidance (minimum collateral damage). These considerations have led to the requirement for autonomous, all-weather, countermeasure resistant, precision seekers for our weapons.

- A near-term goal is to demonstrate a Synthetic Aperture Radar (SAR) seeker (Figure 5) capable of guiding a conventional direct attack weapon to a fixed high value target within 3 meters in adverse weather and at a cost of less than \$40K per unit in quantities of 5000.

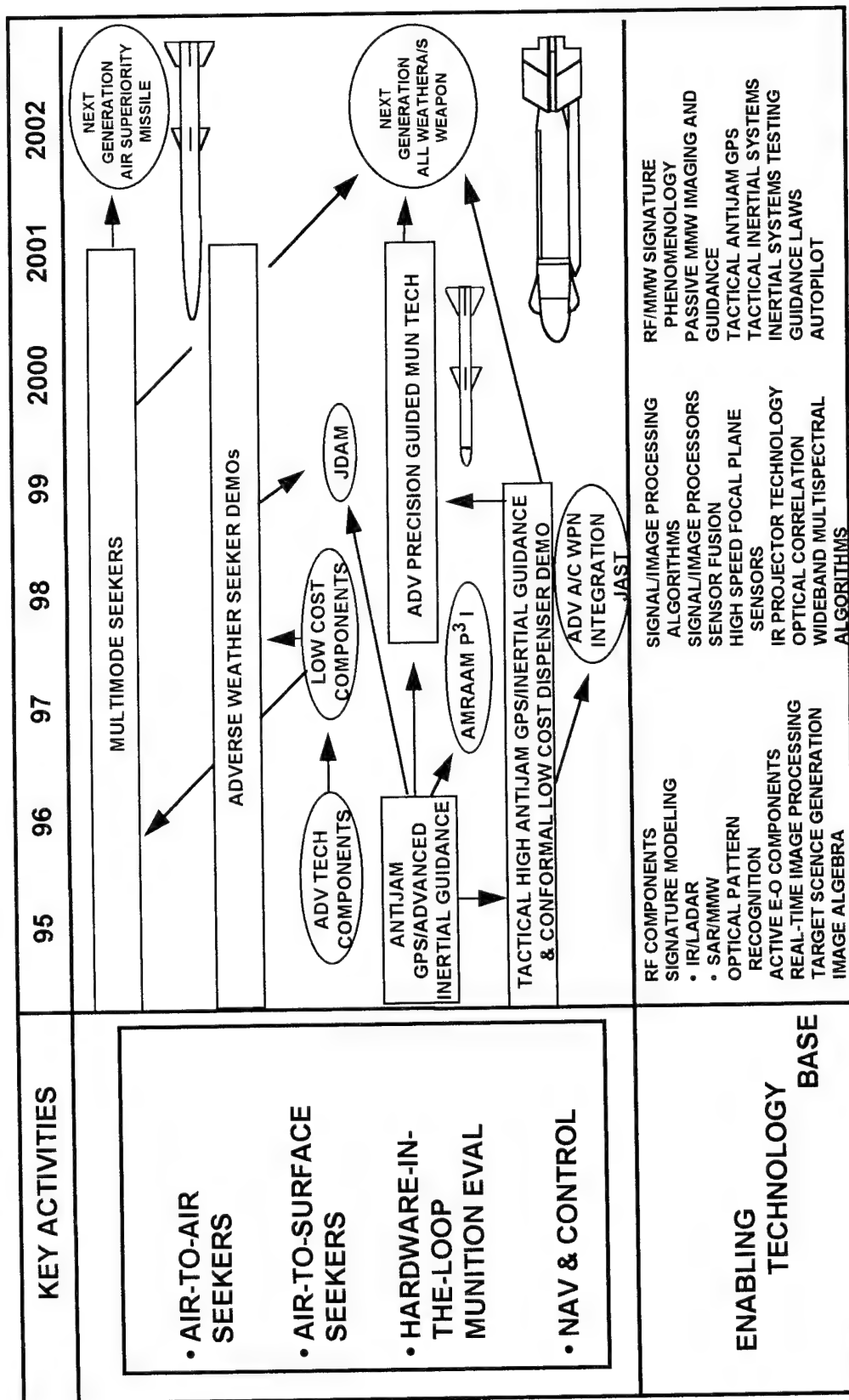


FIGURE 4. THRUST NO. 1 - ADVANCED GUIDANCE

Real-time targeting offers mission flexibility in a rapidly changing battlefield. It allows an update in the coordinates of a mobile target as well as the opportunity to change to an alternate high value target. Several techniques are being investigated to address this capability, to include using data from either on-board or off-board sensors. In addition, the seeker may use inputs from multiple types of sensors operating in different parts of the electromagnetic spectrum.

- A mid-term goal is to demonstrate real-time targeting for a SAR seeker using either on-board or off-board sensor information.

Acquiring and attacking fixed hard targets presents some unique problems. In order to employ penetrating weapons optimally, the seeker must be able to acquire the target in a steep dive angle and remain locked on until target impact. Also, detecting damage following attack is difficult, especially for buried or covered targets such as command control bunkers and aircraft shelters.

- Develop seekers capable of all-weather autonomous acquisition and precision tracking of fixed hard targets at steep dive angles.
- Develop and demonstrate methods to obtain real time battle damage assessment for fixed hard targets.

Traditionally, to mission plan for a strike against fixed high value targets with stand-off weapons can take up to several days. This timeline begins from receipt of targeting material through reference template generation to validation. Because of this, the number of sorties flown and targets attacked in a given time period is limited.

- Develop algorithms and user friendly tools which will reduce mission planning times from days to minutes to increase sortie generation.

Mobile targets such as tanks, trucks, relocatable missile launchers or radar sites have special seeker requirements for both stand-off and direct attack deliveries. To meet the user's need for defeating this broad spectrum of targets, an affordable laser radar seeker has been coupled with a multi-mode warhead in a maneuvering anti-materiel submunition. The

seeker provides highly accurate guidance and enough information to determine which mode should be used to maximize lethality on the target.

- Develop an improved low cost seeker which combines autonomous target identification and tracking of mobile targets in weather with increased area coverage.

Distinguishing friend from foe when forces are in close contact is required for all-weather environments. To accomplish this task, the seeker must have precise angular and range resolution together with the capability to process at extremely high data rates.

- A mid-term goal is to exploit the technologies of high resolution laser radar, optical processing, and image algebra to develop new seekers. These seekers will have high speed, compact parallel processors capable of processing high resolution images in less than 10 milliseconds and algorithms which will find and identify targets in an adverse weather, clutter/countermeasured environment, using high resolution solid-state laser radar sensors.

GPS/Inertial guided munitions are currently being developed for direct attack and stand-off applications. GPS/Inertial guidance provides a low cost, highly accurate, day/night, all weather guidance system for tactical weapons. GPS/Inertial weapon guidance, whether used alone or with a terminal seeker for precision accuracy, is the way of the future. But, jamming threats exist, and more are postulated. The intensity of jamming encountered by a weapon is more severe than that encountered by an aircraft because of the weapons proximity to collocated jammers at the target which could render the weapon GPS receiver useless, thus severely degrading weapon terminal accuracy.

- The goal is a low cost, small GPS/Inertial weapon guidance system for all weapon options which will be impregnable to jamming by all postulated threats.
- This thrust contains the only program within DOD that addresses the antijam GPS technology for tactical weapons. This technology supports the Joint Direct Attack Munition (JDAM) and all future tactical weapons.

Low cost, highly reliable, miniature IMUs are essential for all air-to-air and air-to-surface weapon options, and for GPS/Inertial guidance systems. Current IMUs are large, expensive, and lack accuracy and reliability.

- Our goal is to develop, demonstrate, and mature a new generation of IMUs which are highly reliable, one-fourth the cost, and one-third the size of current systems. They will also have dual use potential for all types of commercial sensing devices.

AIR-TO-AIR

Efforts relating to medium range missiles are primarily concentrated on technologies to improve the AIM-120 AMRAAM. These include lower cost components, increased electronic countermeasure resistance against a broader target spectrum and identification of friend or foe.

- Develop a multi-mode seeker with enhanced processor hardware and algorithms to improve the target identification capability and end game accuracy.
- Provide enhanced performance against post-2000 advanced electronic countermeasures and low observable threats.
- Provide acquisition and shoot-down capability of cruise missiles.

There are current investigations under way to improve the performance of seekers for short range air-to-air missiles. The Armament Directorate is assisting in a number of technology areas to address the specific problems of high off-boresight lock-on and track with emphasis on reduction of component costs.

- Develop and demonstrate a low cost seeker with an electronic steerable conformal array antenna to provide rapid scanning of large fields-of-regard.

In addition to the target oriented goals listed above, there are goals for support technologies which apply across the board to all target types, for both air-to-air and air-to-surface. These include developing research test beds, modeling, and simulation tools which reduce development and life cycle testing

while providing specific seeker performance information as well as overall reliability, maintainability, and supportability data.

- The goal is to develop advanced guided munition simulation and simulator technologies and techniques in order to provide reliable and affordable assessments early in the seeker development process. Advancements in simulator scene projectors, scene generation computer codes and hardware, flight motion simulators and real-time computer hardware will significantly increase the fidelity and utility of ground test facilities and reduce the magnitude of expensive flight test programs.

- To further the goal of identifying affordable concepts and components and reducing the life cycle cost of seekers, we are developing in-house research test beds. These include MMW Reflectivity Measurement Systems (MRMS), Research and Seeker Emulation Radar (RASER), a laser radar brassboard, a digital imagery workstation for mission planning applications, and the Advanced Guidance Research Facility (AGRF).

Missile effectiveness can be significantly increased by applying new target state estimation techniques, new guidance laws, and robust autopilot designs to optimize missile trajectories for faster intercept and increased terminal accuracy.

- The goal is a fully integrated guidance and control system which is capable of providing higher single-shot-kill-probabilities for missiles such as AMRAAM. An additional goal is the development of an innovative guidance law to replace the time honored but limited "proportional navigation" which was invented in 1948.
- This technology is also applicable to the air-to-surface area.

MAJOR ACCOMPLISHMENTS

Conducted captive flight testing and data collection of a SAR seeker in a steep dive trajectory. The data were analyzed to identify phenomenology and operational characteristics of operating a SAR guided weapon in a direct attack mode.

- Completed preliminary applications study of SAR seeker technology to the Joint Direct Attack Munition (JDAM).
- Initiated a FY95 new start program to integrate a SAR seeker onto an AGM-130 to demonstrate seeker-to-weapon integration and terminal accuracy.
- Used the digital imagery workstation developed under the Talon Scene program to explore methods to generate SAR templates using the Digital Point Positioning Data Base and other imagery products.
- Patented a High Speed Image Processor Architecture (HIPRA) in FY94 which is currently being evaluated for incorporation into a consortium with Martin Marietta for a program designated High Speed Algebraic Logic (HSAL) Commercialization.
- Developed and flight tested an optical correlator demonstrating the ability of an optical processor with ternary filters to identify ground targets in real time.
- Demonstrated three dimensional imaging of targets by a solid state-laser sensor at 10-kilometer range.
- Prototyped and demonstrated a suite of government owned, nonproprietary LADAR autonomous target acquisition/identification algorithms against a wide spectrum of critical mobile targets.
- Demonstrated Smart Tactical Autonomous Guidance (STAG) algorithm capability to perform transformation of images to other vantage points.
- Provided MRMS reflectivity data on competing camouflage nets to Joint Camouflage, Concealment and Deception SPO.
- Provided quick turnaround data analysis in support of the ARPA Technology Reinvestment Program Autonomous Landing Guidance program.
- Completed five test entries involving infrared (IR) scene generation, injection, and projection to address the problem of designation and discrimination of Theater Missile Defense targets in the presence of debris.
- Established and defined new calibration methods for nonuniformity correction of resistor array IR projectors. Extensive testing demonstrated reliable highly repeatable calibrations. Nonuniformity corrections are critical for discriminating IR signatures with low intensities against low background clutter.
- Completed initial development and testing of a GPS antenna/filter which nulls jamming signals. Demonstrated jam resistance far exceeding current GPS antijam technology.
- Submitted two patent applications for new missile homing guidance laws. These guidance laws do not require an estimate of time-to-go and yield superior performance in detailed six degree-of-freedom simulations.
- Initiated a program to flight test an optical correlator sensor in a low cost unmanned air vehicle (UAV) flight test program.
- Began analysis of MMW target acquisition and tracking in active and passive modes as well as sensor fusion algorithms using the Modular Algorithm Concept Evaluation Tool (MACET).

CHANGES FROM LAST YEAR

- The Hammerhead program was approved for an FY95 start to provide a synthetic aperture radar seeker demonstration program for the Joint Direct Attack Munition Product Improvement Program (JDAM-PIP).

MILESTONES

AIR-TO-SURFACE

- Captive flight testing of the SAR weapon for the Hammerhead program will begin in FY97, followed by free flight demonstrations in FY97.
- Demonstrate real time targeting for a SAR seeker using either on-board and off-board sensor information in FY99.

- Captive flight tests of low cost solid-state laser radar seeker were flown against targets out to 10 kilometers in FY95.

- The optical correlator successfully tested in FY95 will be integrated with a laser radar. A flight test of this seeker to demonstrate target acquisition in a severe clutter environment will be conducted in FY96. The processor in the seeker will occupy less than 5 cubic inches and weigh less than 1 pound but have an equivalent processing capability better than a Cray computer.

- In addition to the optical processor, an all-digital image processing device is being developed. In FY95 the HSAL program was initiated to develop processor chips which can process the data equivalent to a full size television image in real-time using image algebra derived equations. Successful completion of the program in FY98 will provide a low cost programmable processor which can be used in future missile guidance systems.

- Design, develop, and build an adverse weather, wide field-of-regard, high resolution, passive, millimeter wave (MMW) sensor. This sensor is directed toward meeting user requirements for a covert seeker. Testing will be conducted in FY96 with program completion scheduled in FY97.

- Conduct RASER determinations of exploitable MMW phenomenology for the improvement of smart munition guidance systems in FY96.

- Explore active and passive real beam MMW imaging technologies in FY96 and FY97 for application to a covert air-to-surface seeker.

- Initiate a program to develop laser radar brassboard to evaluate new low cost components and algorithms which will provide the next generation, high resolution seekers in FY96.

- Version 4.0 of the computer code from the Infrared Modeling and Analysis (IRMA) program will be released at the end of FY95. This code allows realistic generation of spatially correlated active and passive infrared and active and passive MMW target and background scenes. In FY96 a new contract for Multisensor Modeling and Analysis (MSMA) will be

let to continue Infrared Modeling and Analysis (IRMA) development to include the addition of new wavebands, sensor models, and air-to-air capabilities.

- Testing began in FY95 of a closed loop simulation of an infrared seeker that will generate in real time spectrally, temporally, spatially, and radiometrically correct target and background scene sequences. These sequences will be used to demonstrate a high fidelity infrared scene projector in FY97.

- In FY95 the digital imagery workstation developed under the Talon Scene program was used to explore methods to generate SAR templates using the Digital Point Positioning Data Base. In FY96 the results from this program will be applied to the precision SAR seeker development for direct attack munitions.

- In FY96 microchip laser sources will be tested and installed in laboratory research testbeds to determine applicability and performance gains. Microchip technology promises higher performance, lower cost, and reduced size.

- A GPS/Inertial guidance system with sufficient jam resistance to meet all postulated threats, costing less than \$25K each and less than 200 cubic inches, will be delivered for ground testing in FY95. Flight testing of this key technology will be conducted in FY99. An advanced GPS/Inertial system capable of differential corrections which will cost less than \$15K and is less than 100 cubic inches will be delivered for ground testing in FY99.

- In FY95 a fiber-optic gyroscope based IMU which will be 25 cubic inches and cost less than \$6K each will be delivered for Air Force testing and integration. In FY99 a highly reliable, extremely small (less than 15 cubic inches), IMU which can be produced for less than \$2K each will be delivered for Air Force testing and integration with advanced GPS/Inertial guidance systems and transferred to weapon Preplanned Product Improvement (P3I) programs (e.g. AMRAAM, JDAM).

- Demonstrate active LADAR scene generation capability for integration into hardware-in-the-loop testing. Demonstrate concept feasibility in FY96. Integrate full-up system by FY99.

AIR-TO-AIR

- In FY96 apply signature modeling capability from the IRMA program and the codes from the Composite High Altitude Maneuvering Post-Boost Vehicle Program to air-to-air scene generation and analysis.
- Begin developing and testing affordable passive electro-optical/infrared, seekers which are sensitive to longwave infrared, multicolor, and polarization signatures to provide improved air-to-air terminal seekers in FY98.
- In FY96 complete the conformal antenna design for the next-generation air superiority missile. Integrate the antenna with a high speed munition processor in FY97 and captive flight test the seeker in FY98.

THRUST 2 ORDNANCE

USER NEEDS

The focus of this Thrust is to introduce affordable, high probability of kill, conventional weapons to the Air Force inventory. The user needs presented below are extracted from Operational Requirements Documents, munitions TPIPT study efforts, the ACC Mission Area Plans for Counter Air, Strategic Attack/Interdiction, Close Air Support/Interdiction, Theater Missile Defense, Electronic Combat, and the Air Force Special Operations Command (AFSOC) Weapons System's Roadmap, 2nd Edition.

AIR-TO-SURFACE

Fixed Target/General Purpose Weapon Options

- All-up round fuzing to reduce support costs
- Insensitive explosives to reduce safety hazard
- Jam resistant proximity sensor
- Enhanced kill mechanisms for increasing effectiveness of smaller weapons

Fixed Hard Target Weapon Options

- Smart fuzing to optimize warhead burst point
- Increased aircraft loadouts through reduced warhead size and compressed carriage
- Increased explosive performance
- Increased mission kill capability and payload flexibility
- Neutralize biological and chemical targets
- Hard target fuzing for gunship projectiles

Fixed Target Weapon Options (Standoff)

- Force multiplier submunitions/munitions
- Unitary heavy metal penetrating warheads

Mobile Target Weapon Options (Direct and Standoff)

- Multimode warhead effective against a broad spectrum of materiel targets
- Insensitive explosive for submunitions
- Reduced cost per kill and increased kills per aircraft sortie

AIR-TO-AIR

Medium and Short Range Missile Options

- Improved warhead burst point control
- Enhanced lethality warheads
- Fuzing for low observable threats
- Guidance integrated fuzing
- Increased maneuverability, performance and aircraft loadouts

See Figure 6 for major Thrust efforts.

GOALS

AIR-TO-SURFACE

For safety and reliability, bomb fuzes are environmentally sealed and stored in separate containers from the bomb bodies. The fuzes, when removed, must be used within 60 days. Lessons learned during Desert Storm demonstrated that the logistics pipeline and build-up effort for general purpose bombs were excessively complex, expensive, and time consuming.

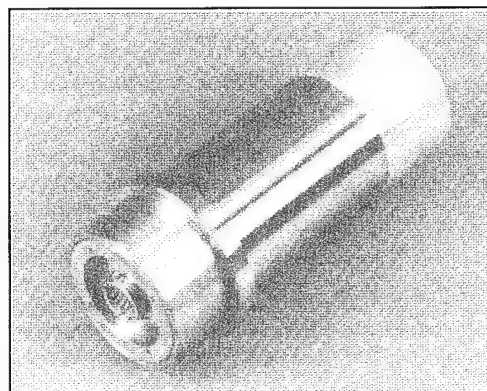


FIGURE 7. HARD TARGET SMART FUZE

- Advances in solid-state electronic fuzing and insensitive explosive booster designs will make safety, reliability, and longevity of fuzed general purpose bombs during transport and storage practical.

- Solid-state electronic fuzing with large insensitive boosters can be used with present Mk-80 series bombs; however, the payoff in safety does not come until the bombs are filled with insensitive explosive. It is too

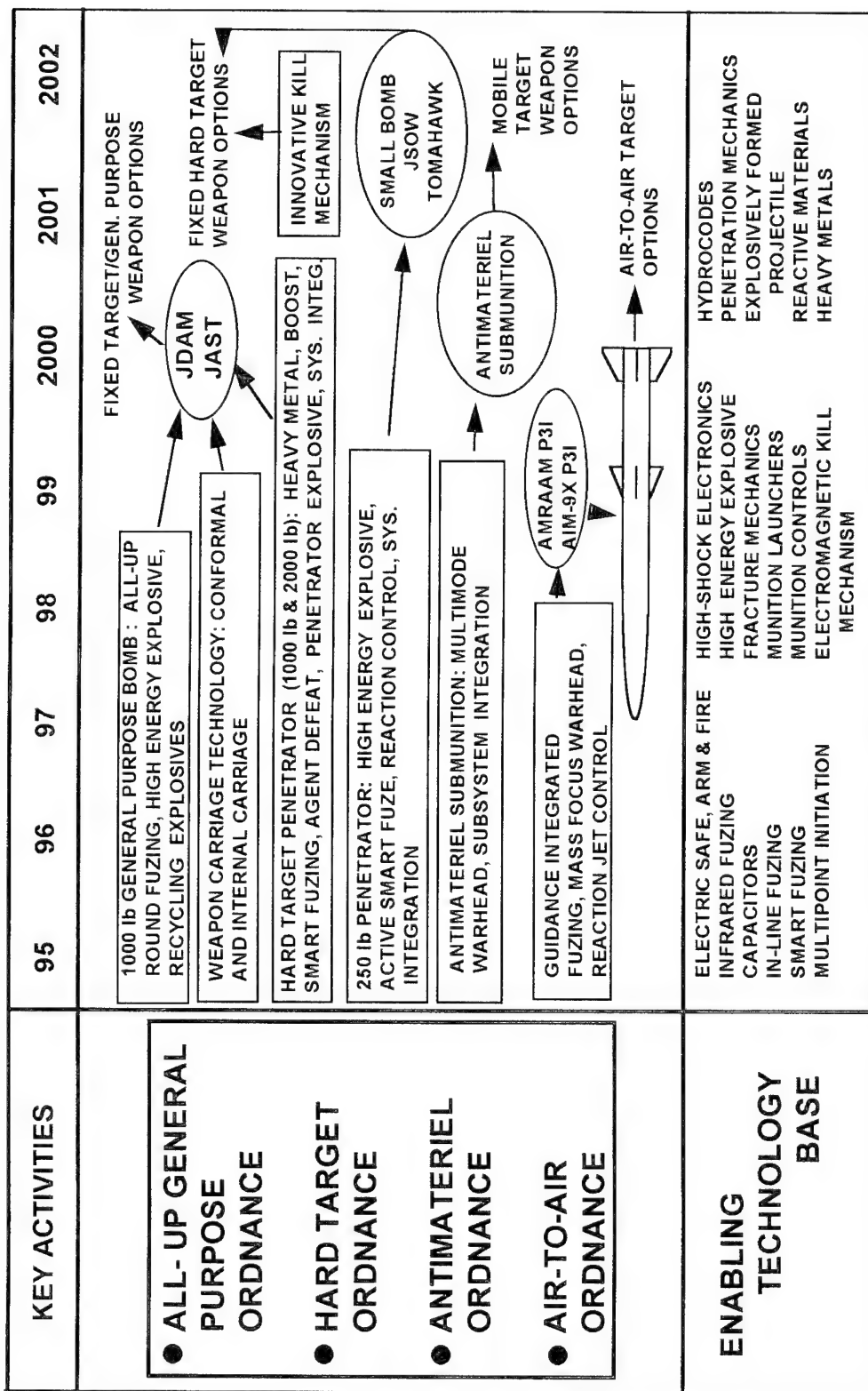


FIGURE 6. THRUST NO. 2 - ORDNANCE

costly to retrofit the large quantity of Mk-80 series bombs already in the inventory with insensitive explosives. The best strategy is to advance and introduce fuze technology now and introduce an insensitive explosive fill during future general purpose bomb buys.

General purpose bombs use proximity sensors to increase blast and fragmentation effects on soft targets. These sensors are expensive, bulky, and susceptible to electronic countermeasures (ECM) and jamming. The present proximity sensor fits in the bomb nose fuze well and causes the bomb to carry a tail fuze with the associated build-up costs.

- Advancements in monolithic microwave integrated circuits (MMIC) and wideband radar technology will lower the cost and will improve reliability and supportability of these sensors.
- Advances in digital signal processing will reduce susceptibility to ECM jamming.
- The Joint Programmable Fuze being procured in the JDAM program is a general purpose bomb fuze which interfaces with a nose proximity sensor. It does address the All-Up Munition issue of storage life but not the solid-state electronics and fuze fire train needed to make it safe for transporting and storing in the warhead or the ECM hardened proximity sensor issues. We envision the All-Up Munition technology area to provide product improvement options for the Joint Programmable Fuze.

Aircraft costs are directly related to aircraft weight, thus the continuing emphasis is reduction in size and weight of the total weapon system (aircraft and armament). Kill mechanisms for delivering more energy on the target or more effectively coupling energy into the target are being explored. These technologies provide the opportunity to reduce the weapon size and weight while maintaining the effectiveness currently available in larger munitions. Smaller, highly effective weapons result in reduced aircraft stowage volumes/areas and thus reduced aircraft size, weight and costs.

- Develop innovative kill mechanisms which couple explosive and electrical energies to enhance the destructive power delivered to the target. Investigate

capabilities obtainable from simultaneously applying multiple kill phenomenology to targets.

For fixed hard target weapon options, we develop ordnance capable of penetrating complex hard targets such as heavily hardened command and control bunkers, aircraft shelters, runways, and concrete buildings. We also develop smart fuzing technology with layer counting, depth of burial, void sensing, and programmable time delay capabilities. To improve weapon accuracy and performance, we use low cost inertial guidance and optimized impact conditions through trajectory shaping and use of reaction control systems such that the weapon and weapon velocity are vertical to the target at impact.

Warhead case and hard target fuzing technologies are emphasized that reduce cost, improve producibility, and increase reliability of penetrator munitions.

The design trades to determine the penetration requirements and number of weapons needed to defeat hardened targets with affordable weapons are very complex. To begin such a study, a definition of the enemy target set and the tactics of the delivery platforms are required. With no clear enemy today, a specific target set cannot be defined. Also, delivery tactics have many variables and are designed to be unpredictable to ensure aircraft/pilot survivability. Aircraft ability to survive at high altitude and find targets through cloud cover are two variables that have a dramatic effect on the decision to boost a weapon or let it free fall. Boosted munitions affect affordability, aircraft compatibility, and the number of munitions that can be carried. There is an inverse relationship between numbers of targets and penetration depths needed to defeat the target. The advanced penetration capability is more expensive but also more effective against heavily hardened targets. But these targets are fewer in numbers requiring fewer weapons to defeat them. For a given impact velocity, the penetration capability decreases with the decreasing size and weight of the penetrator. However, the number of weapons that a platform can carry increases with the decrease in penetrator weight. These penetrator design trends indicate that a two-pronged approach is best: a high payoff deep

penetration capability and an increased force multiplier capability (carriage of more weapons).

Two penetrating munitions in the inventory today are the GBU-27 and GBU-28. Both are non-boosted, laser guided systems and use fixed time delay fuze technology. Operational effectiveness is degraded when using fixed time delay fuzing because accurate intelligence data on the design and construction of all hard targets are lacking. A layer counting fuze with a void sensing capability only requires general construction data about a target to be optimally effective.

The GBU-28 with deep penetration capability, has poor aircraft compatibility characteristics and a very limited employment envelope, i.e., only two aircraft types, severe maneuver restrictions, high altitude release, and clear day. This drastically reduces its utility in time critical scenarios or operations where we do not have complete air superiority. The GBU-27 has better aircraft compatibility characteristics but has less penetration ability. Its 2000-pound weight and the small number that can be carried on aircraft severely limit its capability as a force multiplier. The JDAM program will increase the force multiplier capability of the 2000-lb warhead by incorporating inertial guidance and qualifying it on bomber aircraft (multiple kills per pass with bomber aircraft). However, a severe limitation of both GBU-27 and GBU-28 systems is the lack of a reliable and smart fuze and a multiple kills per pass on fighter size aircraft. Hard target technology will provide design options for product improvement of ordnance packages for JDAM in the 1000-lb and 2000-lb class warheads and a 250-lb class ordnance package for multiple carriage on fighter aircraft.

- Develop a smart fuze with void sensing and layer counting capability to provide accurate warhead burst point control for complex hard targets. The fuze will count floor layers and detonate the warhead in a predetermined void (room). The first generation smart fuze transitioned into the GBU-28 program in FY95. The fuze is also compatible with the GBU-27.

- Develop velocity augmented warhead technology which can accelerate warheads for deep penetration, but at sizes and weights which can be carried on a

variety of attack aircraft. The ordnance package would be an option for a replacement for the gravity drop BLU-109 warhead presently planned for JDAM.

- Develop inertially aided small bomb technologies for hard targets which would provide multiple carriage per aircraft station and defeat multiple structures on a single sortie. Technologies required are low cost inertial guidance and second generation Smart Fuzing (autonomous decision making rather than preprogrammed).

- Develop options for heavy metal penetrating warheads. The payoff would be improved penetration over the present steel case designs (more weight per cross section) for both gravity and velocity augmented concepts.

Current and developmental air-to-surface weapons are typically right circular cylinders with large aerosurfaces and control fins. These weapons require large areas/volumes for aircraft carriage and have large incarriage drag and signature. Current penetrator weapons such as the GBU-27 and GBU-28 utilizes canard controls to steer the weapon to the target. This type of control system provides little maneuverability and results in suboptimum penetrator impact conditions. Reaction control technology coupled with onboard inertial measurement unit and guidance laws to reduce angle-of-attack and optimize the impact angle offer significant improvements in weapon performance and effectiveness. This technology is vital to improving aircraft mission effectiveness by improving range/payload, aircraft survivability, and kill per sortie while reducing cost per kill. This technology is vital to improving aircraft mission effectiveness by improving range/payload, aircraft survivability, and kill per sortie while reducing cost per kill.

- Develop weapons which can be carried conformally or internally with minimum stowage volume. Implement control systems with minimum span aerosurfaces or reaction controls which provide additional reductions to weapon size. Resulting systems will be compatible with external carriage on current aircraft and internal carriage on future advanced fighter aircraft.

Penetrator design requires a thick walled warhead case for increasing penetration and ensuring warhead survivability during the penetration event. This thick wall requirement results in low volumes for explosive fills which, in turn, drives a requirement for higher energy density explosives and new target defeat mechanisms. These advanced target defeat mechanisms can be used individually or combined to provide the effectiveness needed. Target defeat technologies are being developed for large hardened targets such as command, control and communication facilities and for biological and chemical weapon facilities.

- Develop reactive materiel fills for warheads which provide a greater impulse than high explosive for a given volume. This technology would increase the effectiveness of the smaller warhead options for JDAM product improvement.
- Develop electromagnetic energy weapon payloads which provide wide area mission kills against targets which rely upon computers, communication and power systems. Methods for effectively coupling energy from the weapon into the target will be investigated.
- Develop innovative kill mechanisms that will neutralize or deny access to biological and chemical agents in hardened storage or production facilities.
- Adapt hard target smart fuze technology to improve the effectiveness of 105-mm projectiles fired from gunships.

Strategic attack, interdiction, and close air support will continue to be primary missions for advanced tactical aircraft. Targets include enemy air defenses, tactical ballistic missile sites, and the whole range of ground mobile targets such as those included in a motorized rifle battalion. To meet the user's need for defeating a broad spectrum of antimateriel targets, our multimode warhead with enhanced lethality is being developed. The large number of targets and limited aircraft carriage capability requires a cluster munition approach to defeat dispersed ground targets.

Until recently different warheads had to be fielded to get the optimum lethality for each different class of target. Armament Directorate in-house

development has demonstrated the feasibility of a single liner warhead being initiated in any one of the three modes (long penetrating rod, explosively formed aerostable penetrator, or fragmentation). This technology breakthrough enables one submunition to be lethal against the wide spectrum of materiel targets.

Concurrently with the multimode warhead, the Advanced Guidance Thrust has developed an affordable laser diode sensor which can classify, in real time, targets such as tanks, trucks, relocatable missile launchers, or radar sites. This sensor and a maneuvering submunition airframe has matured in the Low Cost Anti-Armor Submunition (LOCAAS) program. The Antimateriel Submunition of the future is envisioned as a second generation smart submunition which will combine autonomous target classification with significantly increased area coverage and a selectable multimode warhead. Detailed cost projections verified by independent government cost analysis indicates these submunitions could be built in large quantities for under \$20,000 each. Joint service use of these effective munitions against ground mobile targets requires them to be carried safely on Navy ships with Navy insensitive munition requirements.

- Continue advancement of multimode warhead technology which can be selectively fired as a penetrating jet, aerostable slug, or multiple fragments. This will provide technology options for next generation antimateriel submunitions.

Current antimateriel submunitions are limited in their area coverage and search patterns, they also have limited lethality against the broad spectrum of antimateriel targets which includes armored vehicles, trucks, and missile sites.

- Continue development of low cost antimateriel submunitions which provide significantly lower cost per kill than existing submunitions. Combine a highly maneuverable, compressed carriage airframe with an affordable laser radar seeker and an enhanced lethality multimode warhead. Resulting capabilities include real-time target classification, the ability to maneuver the submunition to the target and matching of the most effective kill mechanism to the target encountered. The full spectrum of ground mobile targets (trucks, tanks,

surface-to-air missiles, and antiaircraft artillery) can be defeated with a single submunition. Initial development of the sensor and submunition airframe was accomplished in the joint Air Force and Army Low Cost Anti-Armor Submunition (LOCAAS) Balanced Technology Initiative program.

- Develop technologies for incorporating multiple kill methods into a single antimateriel submunition. Potential mechanisms include conventional explosively projected fragments and projectiles, conductivity of high energy currents and transmission of high powered electromagnetic pulses.

AIR-TO-AIR

Enhancement of air-to-air ordnance package performance requires that the target detection device and warhead burst point calculations utilize all information available to the missile. Effective coupling of the warhead energy onto the target requires improvements in directing the kill mechanism such that as much of the kill mechanism as possible interacts with the target. Data from the missile seeker can be used to project the encounter geometry and velocity. Further enhancement of the burst point control algorithms requires that the volume viewed by the target detection device be expanded to cover as much of missile forward hemisphere as possible. Reductions in target signatures requires that the fuze be capable of detecting low observable targets.

- Develop guidance integrated fuzing systems which accurately predict the optimum warhead burst location using all available data from the seeker and guidance packages.
- Develop an imaging seeker/fuze sensor which looks in the forward hemisphere and provides missile/target encounter geometry projections for enhancing warhead burst point calculations and improving effectiveness.
- Develop mass focusing warheads which direct the fragment and blast patterns such that the majority of the warhead energy is coupled into the target.
- Develop fuze sensors which have greater detection ranges against low observable targets in weather.

Improvements in enemy aircraft technology and the proliferation of advanced aircraft have resulted in nations possessing fighter aircraft nearly equal to our own. The weapons suite for these aircraft is in some areas (e.g., aerodynamics) superior to our current systems. Technologies such as reaction jets will eliminate the need for missile fins, providing compressed missile carriage which will double missile loadouts for a given carriage volume.

This technology supports potential future product improvements to the AIM-9 Sidewinder and AIM-120 AMRAAM systems. The munition control system technologies of the thrust are also applicable to the air-to-surface weapon systems.

- Develop technologies for increasing missile maneuverability and high off-boresight launch capabilities. These technologies will provide increased first shot opportunities and minimize the time required for missile launch and destruction of the enemy aircraft.
- Develop advanced low cost, supportable, munition control system technologies which provide decreased missile flight times, high off-boresight, and high angle-of-attack launch capabilities. Technologies such as reaction jets will eliminate the need for missile fins, providing compressed missile carriage which will double missile loadouts for a given carriage volume.

MAJOR ACCOMPLISHMENTS

AIR-TO-SURFACE

- Demonstrated void sensing fuze capability for hard target weapons in GBU-27 and GBU-28 flight tests against hardened underground targets and procured 150 units for testing and deployment in contingency operations.
- Continued large scale tests of agent defeat kill mechanism for neutralizing biological weapons.
- Continued small scale tests of agent defeat neutralization against chemical weapon agents.

- Transitioned hard target fuze for gunship 105-mm projectile; 195,000 units will be produced for Air Force inventory.

- Completed preliminary design for multimode antimateriel warhead brassboard.

AIR-TO-AIR

- Transitioned highly reliable electronic safe, arm and fire device to AMRAAM.

- Transitioned low cost fragmenting warhead with increased effectiveness to AMRAAM.

- Completed testing of jet reaction control device for air-to-air missiles.

CHANGES FROM LAST YEAR

Congressional recommendation was made to fund advanced penetrator efforts with OSD Counter Proliferation funds. Presently receiving funding for heavy walled penetrator design. Joint planning with the Defense Nuclear Agency and OSD is being accomplished for demonstrating technologies to defeat biological and chemical targets.

MILESTONES

AIR-TO-SURFACE

Fixed target/general support weapon technologies

- Demonstrate environmentally protected electronic controller, fire set, and proximity sensor for an all-up munition fuze - FY97.

- Demonstrate explosive recycling technologies which provide low cost recycling of military weapon explosives with environmentally safe products - FY97.

- Demonstrate safety of all-up munition fuze and explosively filled bomb for transportation and storage - FY98.

Fixed hard target weapon technologies

- Demonstrate advanced penetrator explosive formulations for providing insensitive explosive fills which survive penetration while increasing performance - FY96.

- Perform large scale testing of agent defeat kill mechanism for defeating biological and chemical weapons -FY96.

- Demonstrate advanced external weapon carriage suspension and release technologies - FY98.

- Demonstrate 2250-lb and 1000-lb warhead technology compatibility with inertial and precision guidance and develop flight control algorithms to ensure small angle-of-attack at impact - FY98.

- Develop technology for a 2250-lb munition with velocity augmentation and physical compatibility with the F-16, F-15, F-117, F-18, B-1, and B-2 - FY97-FY01.

Fixed target weapon technology (standoff)

- Demonstrate 250-lb force multiplier warhead compatibility with multiple weapon carriage on a single aircraft station - FY97.

- Demonstrate active autonomous smart fuzing hardware and software against runways, buildings, and aircraft shelters. (Fuze describes type of target during the penetration event and autonomously fuzes) - FY99.

Mobile target weapon technologies (direct and standoff)

- Demonstrate compatibility of the multimode warhead with airframe and guidance - FY96.

- Demonstrate lethality of the multimode warhead against ground mobile and relocatable targets - FY97.

- Perform component integration and risk reduction flight testing of the antimateriel submunition technology - FY99.

AIR-TO-AIR

- Demonstrate ordnance package development and evaluation tool as part of an Ada-based, object-oriented

simulation of missile flyout from launch through
fragment/target intercept - FY96.

□ Complete flight testing of reaction control system
for optimizing penetrator impact conditions and
increasing weapon penetration - FY99.

THRUST 3 INSTRUMENTATION TECHNOLOGY

USER NEEDS

The purpose of this Thrust is to provide efficient and affordable instrumentation for Air Force and DoD weapon test requirements. The user needs described below are derived from the the ACC MAP for Strategic Attack/Interdiction, Close Air Support/ Interdiction, the AFSOC Weapon System's Roadmap, 2nd Edition, and the Air Force Test Investment Planning and Programming (TIPP) process.

WEAPONS

Air-to-Surface - All Weapon Options

- Real-time test data
- Blast combustion temperature measurement
- Characterization of behind-panel armor debris
- Warhead effects characterization

TEST AND EVALUATION

Air Force Test Centers

- High Speed Electronic Imaging
- Accurate Time-Space-Position-Information
- Motion holography for wind tunnels
- Subminiature telemetry components

See Figure 8 for major Thrust efforts.

GOALS

This thrust is the only DoD laboratory activity specifically directed toward development of instrumentation technology for weapon Test and Evaluation use. DoD 5000.1 now ties the acquisition milestone decision process to specific exit criteria. This places an imperative on timely test programs, producing accurate and appropriate data to support those decisions.

- The overall goal of this thrust is the development of affordable test instrumentation technology which will allow **dramatic** test cost and schedule reductions for Air Force and DoD weapon acquisition programs. The realization of this goal depends upon two activities: development of the

appropriate technology and rapid transition to test users. This thrust emphasizes both aspects.

WEAPONS/TEST AND EVALUATION

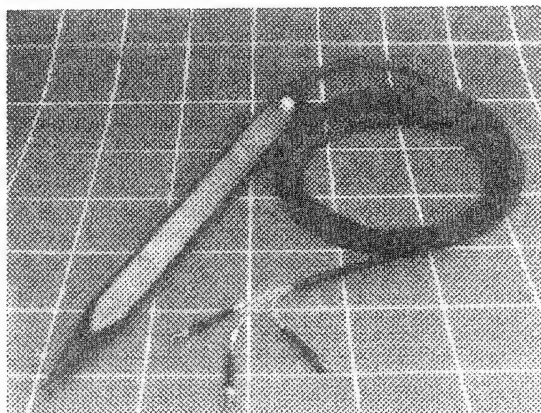


FIGURE 9. FIBER-OPTIC BLAST PRESSURE GAUGE

Real-time telemetry from both air-to-air and air-to-surface developmental weapons is essential for ascertaining whether the system and subsystems functioned properly under realistic flight conditions. Current telemetry systems are too large to allow instrumentation of smaller munitions, submunitions, and missiles. Even where size is not prohibitive, high telemetry system cost has limited instrumented tests to few items.

- Our goal is low cost, subminiature telemetry sets which will support a broad range of weapon test requirements. Implementation is through development of a standard family of specialized telemetry integrated circuit components which can be easily combined into very small weapon specific telemetry systems.

- Near-term goals are to complete development of the Telemetry Instrumentation Development System technology which will provide test users in the field a subminiature telemetry support system. Subminiature telemetry technology is being combined with smart fuze technology to provide operational assessment of weapon function. A low cost spread spectrum demodulator is being developed to receive data from up to 96 instrumented submunitions in simultaneous flight. This technology has great dual use potential for applications such as environmental monitoring of multiple sensors and medical body function monitoring.

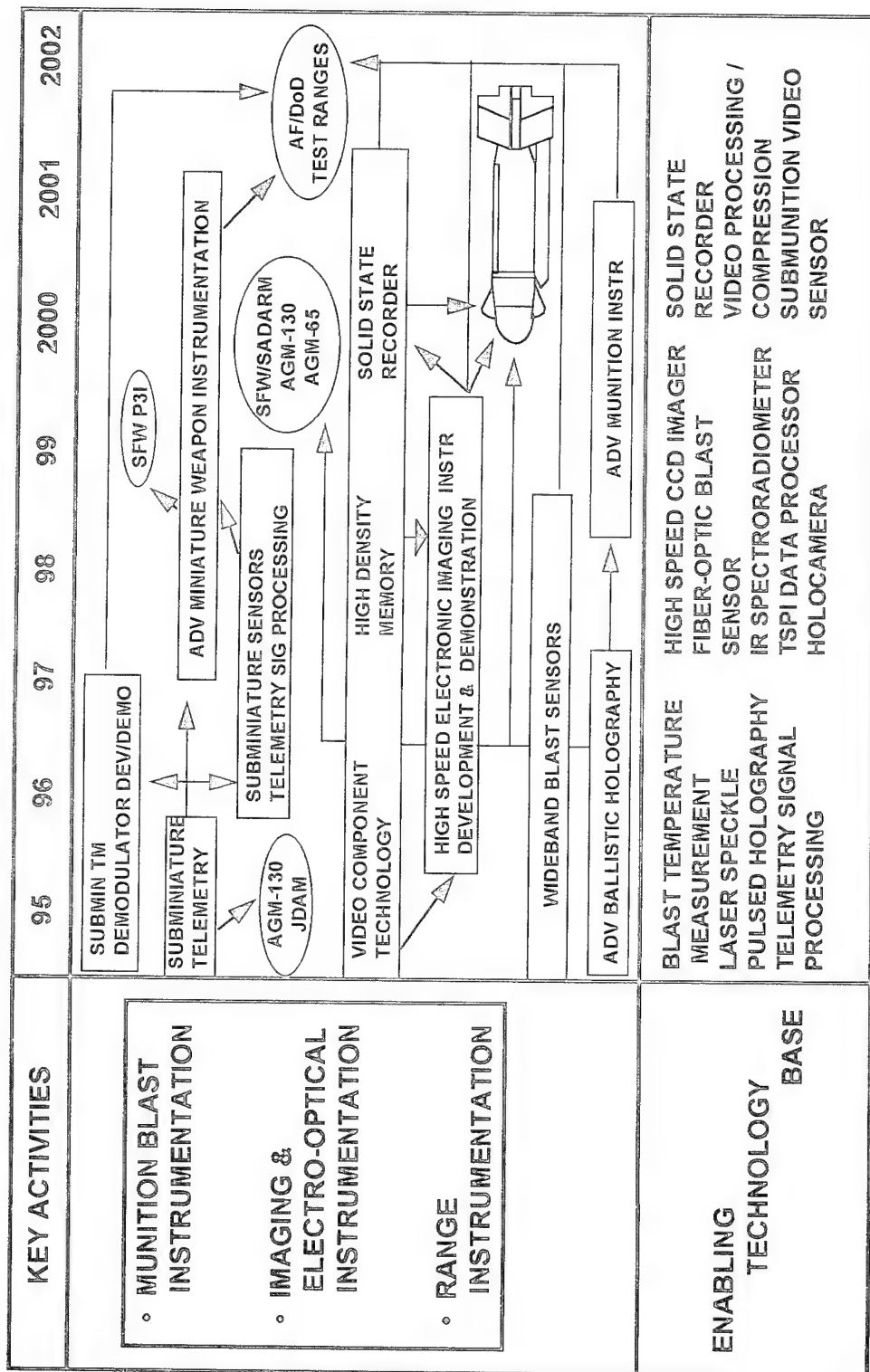


FIGURE 8. THRUST NO. 3 - INSTRUMENTATION

- Payoff will be accurate test data from previously "undoable" weapon test requirements. Telemetry system cost can be greatly reduced while high accuracy data are acquired in digital form. Built-in test capability, installed during weapon production could provide valuable reliability and maintainability data over the full weapon system life cycle while, at the same time, support warfighter training activities. This technology has already been applied to the AIM-120 AMRAAM missile operational telemetry system. AGM-130 and JDAM program offices have recently received subminiature telemetry hardware kits and will support EMD flight tests with them in FY95.

The most widely used form of airborne and ground test data is photography obtained with high speed film cameras. Computer processed metric analysis of high speed film is a standard data gathering technique. Film test data suffer many shortcomings, not the least of which is that film processing takes from days to weeks and data quality is not known until then. Weapon test programs are seriously impeded by film delays. Film processing chemicals are also a serious environmental hazard and present severe operational restrictions.

- Our goal is high resolution, high speed electronic imaging systems which can replace high speed film camera systems and provide test data in real-time. Both airborne and ground applications are being pursued. Modular system components are envisioned to service varying requirements and reduce cost through higher quantity production and commercial use.
- Near-term goals are to 1) develop real-time, high resolution air-to-ground video instrumentation systems and transition to Air Force test centers for immediate improvements to test operations, and 2) develop the individual components needed to support a high speed electronic imaging system advanced development program.
- Payoff will be "film quality" image data that will be available to test and project personnel during the actual conduct of the test. Data quality will be immediately known and scarce test resources can be optimized in real time. Test operational efficiency increases of 300-

500% are envisioned. Operational uses such as reconnaissance and strike battle damage assessment are immediate spin-offs of this technology. Elimination of wet-chemical film processing completely solves that environmental problem and improves field deployability. This technology supports virtually every DoD weapon system acquisition. The Aircraft/Weapon Certification Program (SEEK EAGLE) aircraft-weapon compatibility test and certification program alone has postulated savings of several hundred million dollars through shortened flight test programs.

The effectiveness of advanced munitions is, in large measure, dependent upon warhead design, where the development trend is toward intelligent, multimode, and aimable operation. Improved warhead effects instrumentation must be available to support development of new warhead designs. Current warhead effects instrumentation is too costly and does not have sufficient bandwidth to support intra-warhead data acquisition. Warhead fragment pattern analysis is difficult, with the primary data source, high speed X-ray, providing only orthogonal views of the blast event. Present explosive temperature measurement techniques are inaccurate, yielding widely varying answers.

- Our goal is low cost, wideband blast instrumentation to support weapons development thrusts. This includes the development of both sensors and their support equipments. Developments such as the Fiber-Optic blast sensor (Figure 9), will produce a ten-fold increase in blast pressure data bandwidth. Ballistic Holography will yield true three dimensional views of warhead detonations from which fragment sizes, shapes, and velocity vectors can be determined. Real-time data output, in a computer compatible format is also a high priority. Accurate measurements of the highly transient explosives reaction temperatures will be pursued.
- Payoff will be more accurate and timely warhead test data to support all Air Force weapon developments. Close-in and intra-warhead measurements will allow researchers to verify and extend hypotheses on basic material chemical and physical reactions. Holographic warhead fragment pattern characterization will ultimately yield increased warhead lethality through

improved dispersion analysis. Long range holographic instrumentation will materially speed warhead arena testing.

MAJOR ACCOMPLISHMENTS

- Developed and delivered subminiature telemetry kits to AGM-130, JDAM, and BMDO program offices for flight test support.
- Developed high speed, high resolution charge coupled device (CCD) electronic imager for use in FY96 new start High Speed Electronic Imaging Instrumentation program.
- Transitioned Time-Space-Position-Information Data Processor (TDP) technology to AFDTC for test mission support use. The TDP can process data in real-time from up to ten test range TSPI sensors tracking aircraft and released weapon position, provide an optimal TSPI estimate, and automatically point remote range instruments for flight test data acquisition.
- Completed development of spectro-radiometer instrument to simultaneously measure spatial and spectral infrared target signatures for DoD-wide test applications.
- Produced first ballistic holograms using new in-house laboratory facility. Conducted very successful experimentation to scale up cylindrical hologram size from 6 inches to 24 inches diameter.
- Helmet Video Camera demonstrated during flight tests at AFDTC.
- First Air Force Test Technology Transition Plan signed with AFDTC for Multiple Submunition Telemetry Demodulator.
- In FY96, begin experiments in use of long range holography to provide improved warhead arena test data.
- In FY96 complete development of Telemetry Instrumentation Development System to aid test range telemetry users in field use of subminiature telemetry.
- Begin development, in FY96, of telemetry processing technology to increase transmission range of subminiature telemetry, reduce power input requirements, and provide submunition TSPI.
- In FY97 continue development of warhead effects sensors. Demonstrate fiber-optic warhead blast pressure sensor.
- Flight test Multiple Submunition Telemetry Demodulator in FY96. Transition to AFDTC FY97.
- Begin development, in FY97, of ultra-high bandwidth solid state recorder to support next generation munition flight test requirements.
- In FY96 initiate 6.3 High Speed Electronic Imaging Instrumentation demonstration program
- Develop large scale, test range deployable warhead fragmentation measurement system beginning FY96. Test and transition systems in FY97.
- Test warhead blast reaction temperature measurement methods in FY96.

CHANGES FROM LAST YEAR

There were no major changes from last year.

MILESTONES

GLOSSARY

A/C	Aircraft	lb	pound
ACC	Air Combat Command	LOCAAS	Low Cost Anti-Armor Submunition
ADV	Advanced		
AFAE	Air Force Acquisition Executive	MACET	Modular Algorithm Concept
AFB	Air Force Base		Evaluation Tool
AFDTC	Air Force Development Test Center	MAP	Mission Area Plan
AFOSR	Air Force Office of Scientific Research	MMIC	Monolithic Microwave Integrated Circuits
AFSOC	Air Force Special Operations Command	mm	Millimeter
AGM	Air-to-Ground Missile	MMW	Millimeter Wave
AGRF	Advanced Guidance Research Facility	MRMS	MMW Reflectivity Measurement System
AIM	Air Intercept Missile	MSMA	Multi Sensor Modeling & Analysis
AMRAAM	Advanced Medium Range Air-to-Air Missile	MUN	Munition
ARPA	Advanced Research Project Office	NASP	National Aerospace Plane
A-S	Air-to-Surface	NAV	Navigation
		OSD	Office Secretary of Defense
BLU	Bomb Live Unit	PE	Program Element
BMDO	Ballistic Missile Defense Office	P ³ I; P3I	Preplanned Product Improvement
CCD	Charge Coupled Device	PIP	Product Improvement Program
CEP	Circular Error Probable		
DoD	Department of Defense	RASER	Research and Seeker Emulation Radar
DEMO	Demonstration	RF	Radio Frequency
DEV	Development		
E-O	Electro-optical	S&T	Science and Technology
ECM	Electronic Countermeasure	SADARM	Search and Destroy Armor Munition
EMD	Engineering Manufacturing Development	SAR	Synthetic Aperture Radar
FY	Fiscal Year	SCUD	Short Range Ballistic Missile
		SEEK EAGLE	Aircraft/Weapon Certification Program
GBU	Guided Bomb Unit	SFW	Sensor Fuzed Weapon
GPS	Global Positioning System	STAG	Smart Tactical Autonomous Guidance
		SPO	System Program Office
HIPRA	High Speed Digital Processor Architecture	SUBMIN	Subminiature
HSAL	High Speed Algebraic Logic	SUBMUN	Submunition
IMU	Inertial Measurement Unit	TAP	Technology Area Plan
IR	Infrared	TDP	Time space-Position-Information Data Processor
IRMA	Infrared Modeling and Analysis	TIPP	Test Instrument Planning and Programming
JAST	Joint Advanced Strike Technology		
JDAM	Joint Direct Attack Munition	TEO	Techology Executive Officer
JSOW	Joint Standoff Weapon	TM	Telemetry
LADAR	Laser Radar		

TPIPT	Technology Planning Integrated Product Team
TSPI	Time-Space-Position-Information
UAV	Unmanned Air Vehicle
WPN	Weapon

Technology Master Process Overview

Part of the Air Force Materiel Command's (AFMC) mission deals with maintaining technological superiority for the United States Air Force by:

- Discovering and developing leading edge technologies
- Transitioning mature technologies to system developers and maintainers
- Inserting fully developed technologies into our weapon systems and supporting infrastructure, and
- Transferring dual-use technologies to improve economic competitiveness

To ensure this mission is effectively accomplished in a disciplined, structured manner, AFMC has implemented the **Technology Master Process (TMP)**. The TMP is AFMC's vehicle for planning and executing an end-to-end technology program on an annual basis.

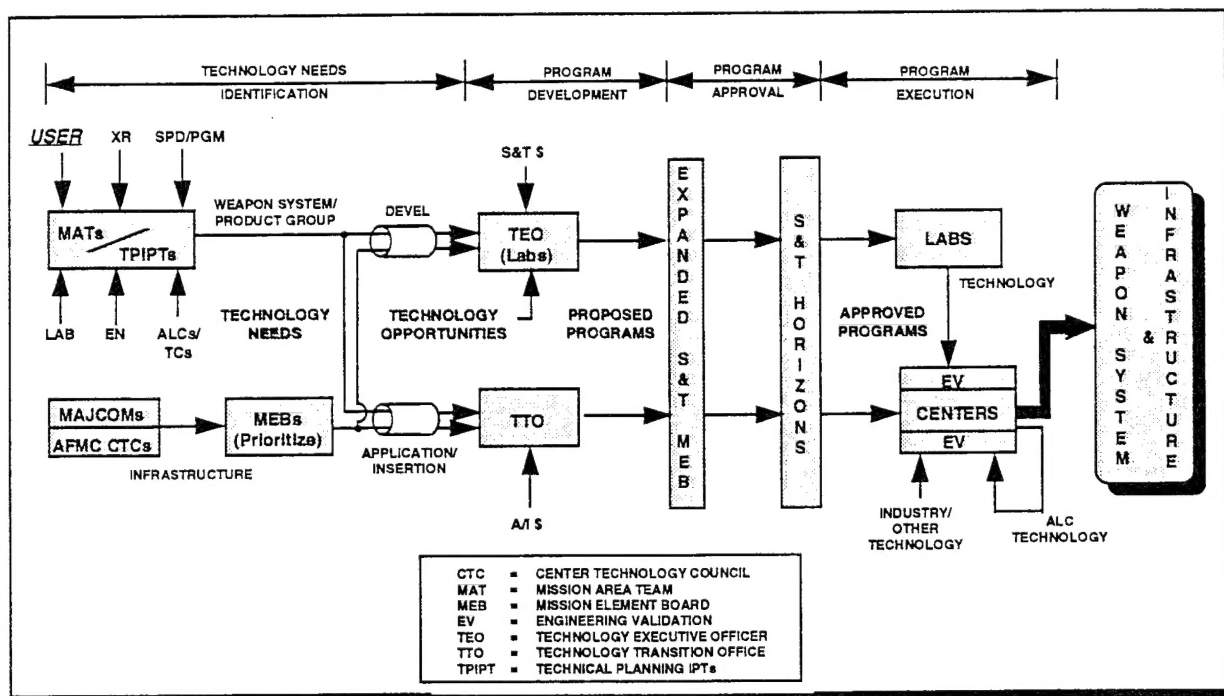


Figure 1 - Technology Master Process

The TMP has four distinct phases, as shown in Figure 1:

- Phase 1, **Technology Needs Identification**--Collects customer-provided technology needs associated with both weapon systems/product groups (via TPIPTS) and supporting infrastructure (via GTCS), prioritizes those needs, and categorizes them according to the need to develop new technology or apply/insert emerging or existing technology. Weapon system-related needs are derived in a strategies-to-task framework via the user-driven Mission Area Planning process.

- Phase 2, **Program Development**--Formulates a portfolio of dollar constrained projects to meet customer-identified needs from Phase 1. The Technology Executive Officer (TEO), with the laboratories, develops a set of projects for those needs requiring development of new technology, while the Technology Transition Office (TTO) orchestrates development of a project portfolio for those needs which can be met by the application/insertion of emerging or existing technology.
- Phase 3, **Program Approval**--Reviews the proposed project portfolio with the customer base via an Expanded S&T Mission Element Board and, later, the AFMC Corporate Board via S&T HORIZONS. The primary products of Phase 3 are recommended submissions to the POM/BES for S&T budget and for the various technology application/insertion program budgets.
- Phase 4, **Program Execution**--Executes the approved S&T program and technology application/insertion program within the constraints of the Congressional budget and budget direction from higher headquarters. The products of Phase 4 are validated technologies that satisfy customer weapon system and infrastructure deficiencies.

TMP Implementation Status

The Technology Master Process is in its first full year of implementation. AFMC formally initiated this process at the beginning of FY94 following a detailed process development phase. During the FY95 cycle, AFMC will use the TMP to guide the selection of specific technology projects to be included in the Science and Technology FY98 POM and related President's Budgets.

Additional Information

Additional information on the Technology Master Process is available from
HO AFMC/STP, DSN 787-7850, (513) 257-7850.

INDEX

- Advanced Guidance: iii, 2,3,4,7,15,23
Adverse Weather: 4,6,9
Aero Propulsion: 3
AGM-130: 8,21,22
AIM-9: 16
Air Force Acquisition Executive: ii
Air Force Materiel Command: Cover,1
Air Force S&T: 1,2,3
Air-to-Air: 4,7,9,10,11,16,17,18,19,22
Air-to-Surface: inside cover,4,7,9,10,11,16,17,19,23
All Weather: i,6
AMRAAM: 7,9,16,17,21,23
Angle-of-Attack: 14,16,17
Antimateriel: ii,15,16,17,18
Army: 16
Autopilot: 3,4,7
Avionics: 3,27

BLU-109: 14
Booster: 1
B-1: 17
B-2: 17

Captive Flight Test: 2,8,9,10
Circular Error Probable: i,ii,23

Damage Assessment: 4,6,21
DESERT STORM: 4,11
Dual-use: 7,19

Electromagnetic: 6,15,16
Electronic Countermeasures: 4,7,13,23
Electro-optical (EO): 10

Fiber-Optic: 9,19,21,22
F-15: 17
F-16: 17
F-18: 17
F-117: 17

GBU-27: 14,17,23
GBU-28: 14,17,23
Global Positioning System (GPS): 2,4,6,7,8,9,23

Hard Targets: 6,13,14
Hardware-in-the-Loop (HWIL): 9
High Speed Imaging: 3
High Speed Video: 2
Holography: 19,21,22

Image Algebra: 6,9
Inertial Measurement Unit (IMU): 3,4,7,9,14,23
Infrared (IR): 8,9,10,22,23
Infrared Modeling and Analysis (IRMA): 9,10,23
Insensitive Explosives: 11,13

Jam Resistant: 4,9,11
Joint Advanced Strike Technology (JAST): 1,23
Joint Direct Attack Munition (JDAM): 7,8,9,13,14,15,21,22,23

Lasar: 2,4,6,7,8,9,14,15,16
Laser Radar (LADAR): 2,6,7,8,9,16,23
Life Cycle Costs: ii,7
LOCAAS: 15,16,23
Low Observable (LO): 7,11,16

Mission Area Plans: 2,4,11,23
MMIC: 13,23
Modular Algorithm Concept Evaluation Tool (MACET): 8,23
Multimode Warhead: 11,15,16,18

National Aerospace Plane (NASP): 1,23
National Laboratories: 3

Optical Processing: 6
Ordnance: iii,2,3,11,13,14,16,18

Penetrating Munitions: 14
Precision Guided: i
Preplanned Product Improvement (P³I): 9,23
President's Budget: inside cover,2
Program Elements (PE): 1,23

Radar: 2,3,4,6,7,8,9,13,15,16

Radiometric: 9

Research and Seeker Emulation Radar
(RASER): 7,9,23

Synthetic Aperture Radar (SAR):

2,4,6,8,9,23

SEEK EAGLE: 21,23

Sensor Fuzed Weapon (SFW): 21,23

Subminiature Telemetry: 2,3,19,21,22

System Program Office (SPC): 3,23

Technology Planning Integrated Product

Team (TPIPT): 11,24

Technology Transfer: 3

Test & Evaluation (T&E): 19

Weapon Airframes: 2

Weapon Flight Mechanics: 3

Wind Tunnel: 19

Wright Laboratory: ii